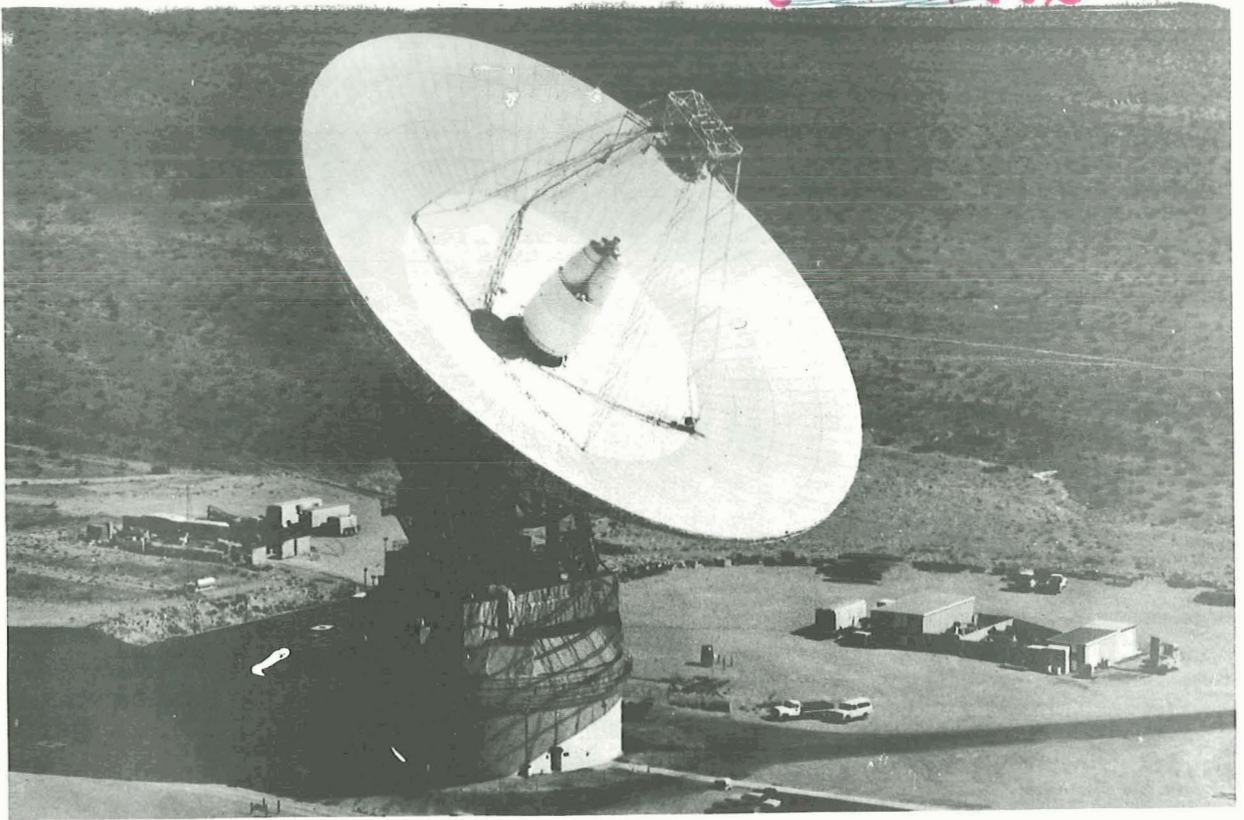


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(Editors: This fact sheet contains information on NASA's Office of Tracking and Data Acquisition. It is suggested that it be retained in your files.)

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DECEMBER 1970

OFFICE OF TRACKING
AND DATA ACQUISITION

The Office of Tracking and Data Acquisition is NASA's eyes, and ears and its memory. OTDA provides the electronic pipeline from all points around the Earth, for flights at great distances and small.

Networks of ground stations and air- and sea-borne equipment provide precision tracking, communication, and data collection. As a major counterpart to other elements of NASA and U.S. and foreign space interests, the OTDA program has its own staff, funds, installations and equipment.

OTDA serves an endless variety of experiments in the air and space, because the research and development programs of NASA, by their nature, constantly change in volume, scope purpose and no two projects are alike. This work is broadly classified and organized to deliver information to and from every experiment conducted anywhere that NASA's flights go. OTDA's broad task categories are as follows.

OTDA Tasks

* Deep space flights requiring continuous precision tracking to the distant planets. Such probes as Mariner, Pioneer and Viking must be followed at distances measured in millions and hundreds of millions of miles away from Earth, where the spacecraft transmits extremely weak signals.

* Unmanned Earth satellites, flying within a few hundred miles of Earth, involve many spacecraft in all kinds of orbits as far out as a few thousand miles, taking large amounts of data. Because they travel near Earth horizons they need coverage by many ground stations.

* The manned flights begin in Earth orbit and terminate in a period of days but they require a combination of highly precise tracking, highly reliable "man rated" voice communication at very long distances and a large volume of information all in real time.

* Many other projects in aeronautical research, in aerial survey or support, research aircraft, free balloons, radar and optical tracking and surveying, and sounding rockets in brief suborbital flight, demand a wide variety of specialized equipment and operations.

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* Tying all NASA operations together, the communication lines carry a heavy load of traffic into the far places of the Earth.

SCOPE OF OPERATIONS

The functions of tracking and data acquisition involve many different tasks. In addition to tracking and telemetering data to the Earth, the network must provide voice crew communications, and command signals to operate the satellite systems; it must detect signals and record, process and distribute the data obtained from space; test and verify its own systems; train its operations staff and control its own operations; determine trajectories and attitudes of flights; and participate in different science experiments.

Because the tracking operations require large, complex stations on foreign as well as U.S. soil, NASA welcomes the opportunity for good will and cooperative work in international science and technology. Wherever located, the stations operate under agreements with the host country, wholly or partly staffed by native talent and always using the maximum available indigenous scientists, engineers, and technicians.

As research and development programs have grown, experiments have increased in complexity, quantity and volume. New flight projects begin, others are reduced, inactivated, or ended, but the total remains about constant. For one indication, the flow of data from some 50 Earth satellites in orbit has more than doubled in the past five years, now amounting to more than 400 million data points, or measurements, every day. And more pours in constantly from deep space tests.

OTDA has full responsibility for this flow of information to bring it to Earth, process and distribute it to the interested scientists and engineers. Those users are thousands of professors and students, laboratory workers and researchers in the U.S. and overseas. The range of experiments is extremely broad and the information they seek may come in frequent short bursts or accumulate gradually over a long period of time.

In one recent average month NASA's STADAN (satellite) network supported 39 active satellites carrying 270 experiments, of which 154 returned information. The data obtained, after complete processing to remove noise or static and other useless matter, filled some 6,000 rolls of digital tape ready for computer use.

The experimenters receive ordinary one-half inch magnetic tapes, each about 2,500 feet long and carrying computer-readable coded information. The tapes contain somewhat over two million bits, or engineering data measurements. This material comes from a collection of satellites and space probes with a full range of orbits and trajectories.

The oldest working satellites are the Canadian Alouette 1, launched (by NASA) Sep. 29, 1962, and OGO-1 (Orbiting Geophysical Observatory) in flight since Sep. 5, 1964. One of the largest producers of data, OGO-5, with 27 experiments aboard, has filled some 40,000 digital tapes since launch on March 4, 1968.

The stations and networks integrate their work on flight projects as needs arise. Thus, the unmanned weather, applications, observatory and other scientific Earth satellites obtain considerable assistance from the Manned Space Flight Network, as well as the normal Satellite Network. For the same reason, the Apollo flights are served by the Satellite and Deep Space networks.

Large volume, integration, and complexity make tracking today far different than it was at the start in 1958. Then, the tasks of tracking and obtaining information were only advancements from the older concepts of aeronautical communication and traffic control.

OTDA has constantly improved its systems and operations over the years to stay abreast of the experiments and programs it serves. The Minitrack, devised in 1957 for the Vanguard program now forms a small part of NASA's global STADAN (Space Tracking and Data Acquisition Network), and the operations are conducted with advanced computer methods and scientific equipment.

ANTENNAS

The successful development of one 210-foot parabolic antenna, in California -- largest of its kind -- has led to the construction of two identical ones in Spain and Australia for the Deep Space Network (DSN). When completed, these will make up a new network delivering more than eight times the precision and distance capability of the 85-foot antenna for exploration in deep space. The new network will be ready in late 1973, in time to support the first unmanned flight to the planet Jupiter and an unmanned landing on Mars.

Tracking support has been a major element of many NASA achievements, including:

- * The first mapping of the Moon by camera, the first landing by men on the lunar surface and the successful transmission of those historic events by television to uncounted hundreds of millions of people all over the Earth.

- * The first probes of the planets Mars and Venus and the first close-up photos of the planets, also furnished to Earth by TV from distances over 30 million miles.

- * The first precision geographical survey of the Earth, with important corrections in maps of the southern hemisphere.

- * Successful experiments with the Einstein theory of relativity based on tracking exercises at distances over 250 million miles.

- * Radioastronomy, gravitational and theoretical experiments with large tracking antennas.

- * Development and improvement of global weather and communication satellite systems, and experiments with passive radio satellites.

- * Flights with many thousands of scientific sounding rockets and rocket- and jet-powered aircraft.

In the future, OTDA expects to develop relay satellites for more effective data acquisition, greater use of wideband communication, transmission in the X-band of the frequency spectrum, and improvement of other electronic systems to meet the constantly expanding needs of the space and aeronautical programs of the United States.

Following are brief descriptions of the OTDA activities and their purposes.

STADAN

The Space Tracking and Data Acquisition Network, or STADAN, has prime responsibility for communication with the unmanned scientific Earth satellites such as the observatory series, communications, applications, Earth resources, and weather projects of NASA, as well as orbiting vehicles launched for American and foreign interests.

Most flights are within a few hundred miles of Earth, although some go into higher, Earth-synchronous (stationary) orbit and a few reach lunar distances.

STADAN has a staff of about 1,500 American and foreign engineers, technicians, maintenance, and administrative employees. Stations have fixed and mobile equipment, and most of them use the Minitrack interferometer system which requires a small beacon on the spacecraft for precision orbit determination. Others have range and velocity instrumentation for very high orbits. Nearly all STADAN installations include Yagi arrays and 40-foot parabolic antennas and some have 85-foot dishes.

NASA's Goddard Space Flight Center manages STADAN and the control center located on Goddard's home grounds at Greenbelt, Maryland. The stations are Fairbanks, Alaska; Rosman, N.C.; Fort Myers, Fla; Mojave, Calif., Winkfield, England; Tananarive, Madagascar; Johannesburg, South Africa; Canberra (Orroral Valley), Australia; Quito, Ecuador; and Santiago, Chile.

DEEP SPACE NETWORK

The focus of the Deep Space Network (DSN) is the void of space, where unmanned scientific spacecraft such as Mariner, Pioneer, and Viking go for information on the solar system and the planets.

Mariners have been tracked as far as one-quarter billion miles away from Earth by DSN. Deep space data are brought, instantaneously (in real time) to the Space Flight Operations Facility at Pasadena, Calif., headquarters of the Jet Propulsion Laboratory (JPL). That was the scene of the first mapping pictures of the Moon from Ranger, Surveyor, and Lunar Orbiter, and close-ups of Mars in 1969.

The complement of DSN is about 900 persons, and the equipment is the basic 85-foot parabolic antenna. New 210-foot antennas under construction at Madrid (Robledo de Chavela), Spain, and Canberra (Tidbinbilla), Australia, will duplicate the large dish operating at Goldstone, Calif. With these three stations located equidistant around the Earth, NASA can track continuously all flights above 10,000 miles while the Earth turns on its axis.

In addition to Goldstone, Madrid, and Canberra, the network has stations at Johannesburg, South Africa; and Woomera, Australia; plus a six-foot antenna at Cape Kennedy for launch trajectory purposes. The DSN is managed for NASA by JPL under contract with the California Institute of Technology.

MANNED SPACE FLIGHT NETWORK

All lines in the manned flight tracking system lead to the Mission Control Center in Houston. There at the Manned Spacecraft Center the headline events of Apollo flights have emanated through television to viewers all over the Earth.

The Mission Control Center is one of the world's most modern computer operations. When the network is in full operation MCC is the focal point of a flight operation involving thousands of persons, 11 tracking stations, the tracking ship Vanguard, and four tracking aircraft over the Pacific. This elaborate array constitutes the control link for all events of a major Apollo flight from the launch pad through travel to, around, and on the Moon, return to Earth, and recovery in the ocean.

Most of the MSFN stations and Vanguard operate primarily for Earth orbit phases of Apollo flights, as they will in future Skylab manned space stations. The ALSEP experiment left on the Moon has been working continuously for more than a year. For distances over 10,000 miles above Earth, the network places heaviest reliance on the stations at Madrid (Fresnedillas), Canberra (Honeysuckle Creek), and Goldstone for 24-hour-a-day communication.

These facilities have 85-foot antennas, each with a second or "wing" antenna for tracking the separated Apollo spacecraft when the Command Module orbits the Moon while the Lunar Module lands there. For that "wing" role, the MSFN regularly uses 85-foot DSN antennas at Madrid, Goldstone and Canberra.

MSFN also calls on the 210-foot Goldstone dish as needed, and may possibly use the 210's in Spain and Australia when they are completed.

All MSFN stations are on Unified S-band equipment using either 30- or 85-foot dish antennas to provide voice communication with astronauts, precision data on position, data acquisition of many kinds, all on one link. Selected stations also have C-band radars for tracking separate from the S-band link

Goddard Space Flight Center manages the MSFN and maintains a large computer complex for Apollo operations at Greenbelt. The mass of data, communications and command signals flow between Goddard and Houston by wideband microwave circuit. The MSFN staff totals some 1,600 U.S. and foreign employees.

In addition to the three major stations, MSFN has tracking facilities at Cape Kennedy, Fla.; Corpus Christi, Tex.; Guam; and Kokee Park, Hawaii; Ascension Island; Carnarvon, Australia; Bermuda; and Las Palmas, Canary Islands.

NASA COMMUNICATIONS NETWORK

The interconnection between all tracking operations, flight missions and ground centers totals some two million miles of telephone, microwave, radio and Earth satellite lines, undersea cable and special wideband circuitry. Operated almost entirely by commercial common carriers on contract, the combination-- known as NASCOM -- is rated the most reliable system in existence.

Reliability is imperative because the success of large, complex and highly costly NASA missions depends on communications -- sometimes involving the lives of flight crews.

Goddard operates the integrated NASCOM system, serving communications needs throughout the global activities of the agency. NASCOM operations are computerized for maximum efficiency and effectiveness as well as reliability.

Without doubt, NASCOM's best known achievement was the TV coverage of man's first steps on the Moon in Apollo 11. NASCOM channeled that historic event through 210-foot antennas at Goldstone and Parkes, Australia, thence by satellite and landline to Houston for relay to U.S. and foreign TV interests. As a result, hundreds of millions saw it on TV all about the Earth.

Less known but more vital was NASCOM's success in furnishing reliable communication to the crippled Apollo 13, when three astronauts were forced to abandon equipment in their Command Module. NASCOM took only a few hours to patch in special connections to the Parkes and Goldstone 210-foot antennas. In the emergency, they were able to maintain an adequate communication lifeline with the astronauts whose transmitter signal was weak because of reduced power.

With a total complement of about 400 U.S. and foreign employees, NASCOM operates a system of major switching centers and subsidiary interconnections wherever NASA experiments go. The major switching points are located at Goddard, JPL, Cape Kennedy, Honolulu, Canberra, Madrid, and London.

OTHER TRACKING ACTIVITIES

The work of tracking and obtaining data goes well beyond the global space networks. Hundreds of programs in aeronautical research, aerial survey, and in sounding rockets require support, and another activity tracks with cameras.

Nearly all sounding rockets fly from Wallops Station, on the Virginia coast. These small rockets usually splash down in the sea within minutes of launch, but the Station averages about 110 flights each year for U.S. and foreign space science interests. In addition to the ground instrumentation, radar and optical equipment supporting this work, Wallops maintains mobile gear for special projects, some in international science. And a few rockets are launched from other U.S. and foreign locations.

Wallops trackers carried out an exceptionally large task in the spring of 1970 by following the course of a Solar Eclipse, aiding science by obtaining data from 33 instrumented rockets which were sent aloft within a short period before, while, and after the Sun was totally blacked out by the Moon.

NASA's optical space tracking is performed on contract by the Smithsonian Astrophysical Observatory, Cambridge, Mass. SAO has a network of eight small stations located around the Earth. Their main purpose is to support Earth satellite programs, as required, with Baker-Nunn cameras, lasers, and other optical devices.

NASA's Flight Research Center, Edwards, Calif., is the scene of most of the OTDA aeronautical tracking work. The 500-mile High Range, from Edwards to Ely, Nev., provides telemetry, tracking, communication, and computing for a wide variety of aircraft. Originally built in 1959 for the X-15 rocket-powered research plane, the High Range today works actively with the supersonic transport research and other specialized aircraft.

The most advanced program at Edwards is the Lifting Body research vehicle -- M-2, HL-10, and X-24 -- the forerunner of the Space Shuttle. The Lifting Body is actually an airplane without wings, has an aerodynamic shape suitable for space flight and for reentering the Earth's atmosphere and landing on the ground under full control of the pilot.

Ground support is also provided to aeronautical projects conducted at other NASA laboratories and to specialized flights in other science and technology programs.

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